Measurement of Microbial Activity in Soil or Atmospheric Dust by Colorimetric Observation of *in situ* Dye Reduction: an Approach to Detection of Extraterrestrial Life

Ronald Crawford, Ingrid Erwin, Lisa Allenbach and Bruce Barnes
Environmental Biotechnology Institute, University of Idaho, Moscow ID 83844;
crawford@uidaho.edu

Abstract

Detecting microbial life in extraterrestrial locations is a goal of space exploration because of ecological and health concerns about possible contamination of other planets with earthly organisms, and *vice versa*. Previously we suggested a method for life detection based on the fact that living entities require a continual input of energy accessed through coupled oxidations and reductions (an electron transport chain). We demonstrated using earthly soils that the identification of extracted components of electron transport chains is useful for remote detection of a chemical signature of life. More recently we used Earth-derived soils to develop a related, but simplified life detection system based on direct observation of a biological redox signature. We measured the ability of soil microbial communities to reduce the artificial electron acceptors 2,3-dichlorophenol indophenol (DCIP) and the tetrazolium dye 2,3-bis(2-methoxy-4-nitro-5-sulfophenyl)-2H-tetrazolium-5-carboxanilide inner salt (XTT). Uninoculated or killed controls did not reduce the dyes. A soil from Antarctica that was determined by chemical signature and DNA analysis to be sterile also did not reduce the dyes. The present version of the technology employs a robotic instrument designed to collect dust or aerosol particles from air and deposit these materials into a bank of nutrient solutions containing various microbial growth media and DCIP or XTT. A remote camera monitors color changes resulting from microbial metabolism in the media that cause dye reduction (color formation with XTT; color quenching with DCIP). Observation of dye reduction provides a simplified means to detect a signature of life in the soils or atmospheric dusts of other planets or their moons.

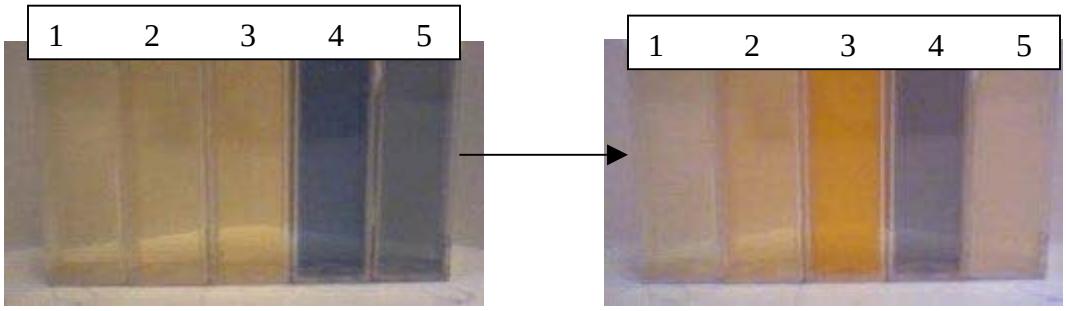

Figure 1: Robotic examination of dust or aerosol samples for living microorganisms

1 = Killed Control (no dye): negative; 2 = Killed Control (XTT): negative; 3 = Positive (XTT) kan^r amp^r *E. coli*: **positive;** 4 = Killed Control (DCIP): negative; 5 = Positive (DCIP) kan^r amp^r *E. coli*: **positive;** Killed controls contained ~1% *p*-cresol; 7-hour observation at 25°C.